Oxidation-Reduction Reactions

Chemistry I

Oxidation-Reduction Reactions

- *Oxidation* is a chemical change in which electrons are lost by an atom or group of atoms
- *reduction* is a chemical change in which electrons are gained by an atom or group of atoms.
- These two changes occur at the same time in a redox reaction.

oxidation numbers

- The concept of ***oxidation numbers*** was developed as a simple way of keeping track of electrons in a reaction. By using oxidation numbers, you can determine whether electrons have been transferred and thereby whether an oxidation-reduction reaction has occurred.

oxidation numbers

- The **oxidation number** (sometimes called the **oxidation state**) of an atom in a substance is defined as the charge of the atom if it existed as a monoatomic ion, or a hypothetical charge assigned to the atom in the substance by a set of rules.

oxidation numbers

- . We then define an oxidation-reduction reaction as one in which one or more atoms change oxidation numbers, signaling that there was a transfer of electrons.

Oxidation Number Rules

- 1. An uncombined element (free element) has an oxidation number of zero (0).
- 2. A monatomic ion (1 atom) has an oxidation number equal to its charge.
- 3. Fluorine's oxidation number is always –1.
- 4. Oxygen has an oxidation number of –2 in all compounds except peroxide where the oxidation number is –1.
- 5. Hydrogen has an oxidation number of +1 except when combined with metals where hydrogen's oxidation number will be –1.
- Ex: NaH (sodium hydride)

Oxidation Number Rules

- 6. All Group 1 elements have an oxidation number of +1. All Group 2 elements have an oxidation number of +2.
- 7. Second element in a binary compound is assigned the oxidation number it would have if it were an ion. (Hint: always negative.
- 8. The algebraic sum of the oxidation numbers of ALL of the atoms in a compound MUST equal zero.
- 9. The algebraic sum of the oxidation numbers of ALL the atoms in a polyatomic ion is equal to the charge on the ion. Ex. Sulfate ion is –2 so all the oxidation numbers in this ion must add up to –2.
- 10. When in doubt ask your chemistry teacher!!!!!!!!!

Electrochemistry

- **Electrochemistry** is defined as the study of the interchange of chemical and
- electrical energy. here we will be concerned with 2 main processes,
- 1. Generation of electrical current for a spontaneous chemical reaction

Electrochemistry

- 2. using an electrical current to produce a chemical change
- Electrochem has immediate implications in the real world. Car batteries,
- calculators portable CD players all use chemical reaction to make electricity.
- On the other hand, charging your car battery or purifying aluminum or electroplating gold on your jewelry are all examples of using electricity to produce chemical change

Galvanic Cells

Are basically batteries.

These can range from a single galvanic cell to several cells linked together, such a car battery.

if we put reagent in separate compartments provide a wire between the two compartments for the electrons to flow through, then we can use the electrical energy to do something useful like run my CD player.

Galvanic Cells

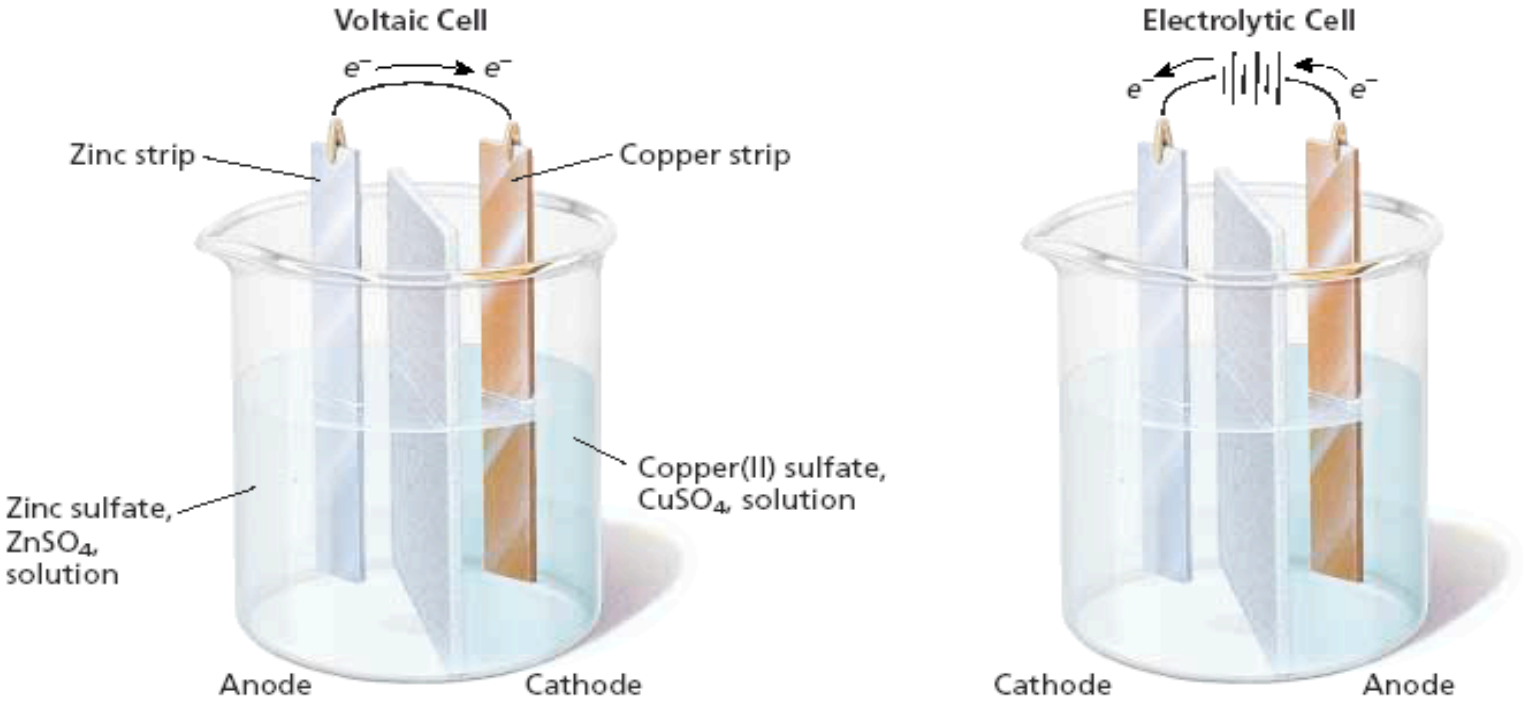
- a **Galvanic cell** is a device by which chemical energy is converted to electrical energy.
- These are basically batteries.
- These can range from a single galvanic cell to several cells linked together, such a car battery.

- if we put reagent in separate compartments provide a wire between the two compartments for the electrons to flow through, then we can use the electrical energy to do something useful like run a CD player
- When we work going the opposite direction (electrolysis) electricity to chemical will see an *electrolytic cell*.

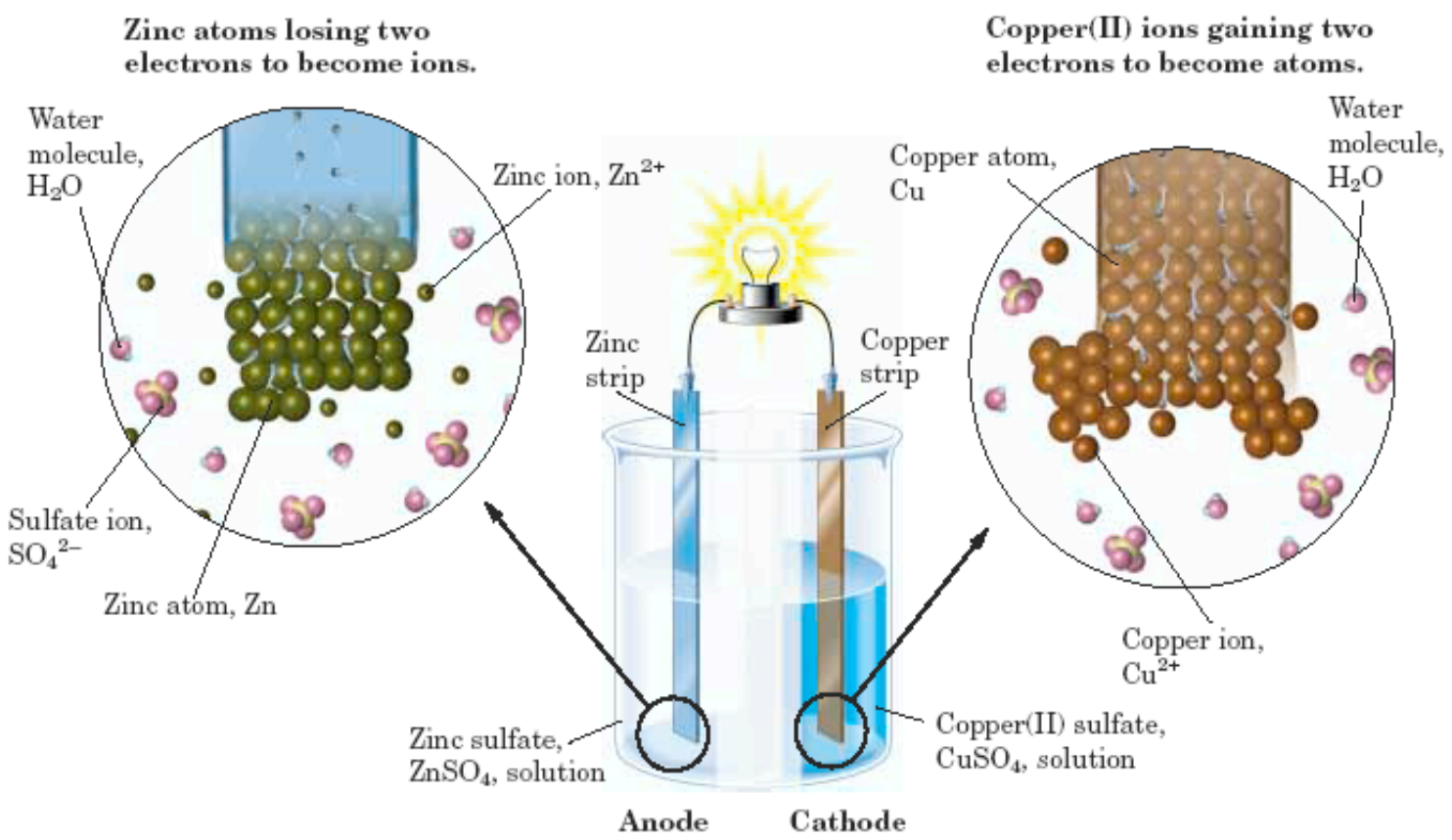
Car Batteries

- Linking 6 of these cells in series produces the **12-volt battery** found in most cars today.
- One disadvantage of these "wet cells" such as the lead-acid battery is that it is very heavy and bulky.
- However, like many other "wet cells", the oxidation-reduction reaction which occurs can be readily reversed via an external current such as that provided by an automobile's alternator.
- This prolongs the lifetime and usefulness of such devices as an energy source.

Comparison of Voltaic and Electrolytic Cells



Particle Models for Redox Reactions in Electrochemical Cells



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Model of a Lead-Acid Storage Battery

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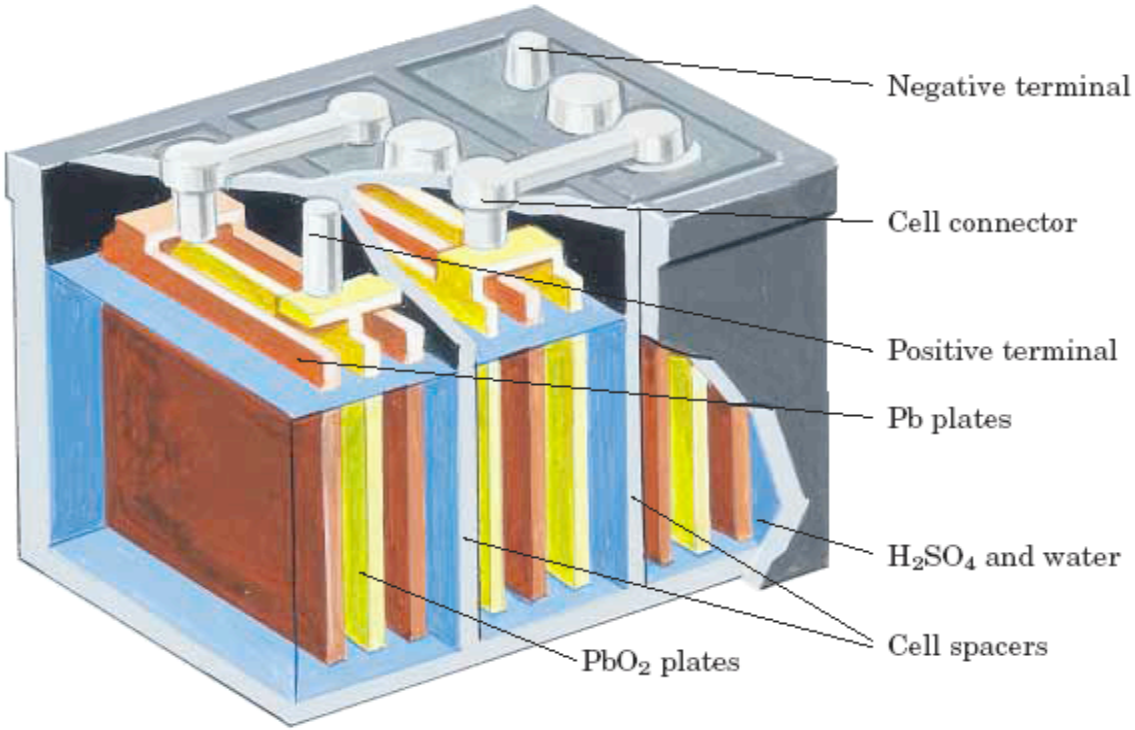


Common Uses

Process	Reaction	Comment
Rust formation	$4Fe + 3O_2 \lozenge 2Fe_2O_3$	The product is Iron (III) oxide or ferric oxide.
Charcoal burning	$C + O_2 \lozenge CO_2$	This is what happens on your charcoal grill.
Burning sulfur	$S + O_2 \lozenge SO_2$	This is one process that occurs in catalytic converters.
Automobile engines at high temperatures	$N_2 + O_2 \lozenge 2NO$	Another wonderful thing that came from catalytic converters.
Burning methane (natural gas)	$CH_4 + 2O_2 \lozenge CO_2 + 2H_2O$	Just like in the wintertime when you run your gas furnace.

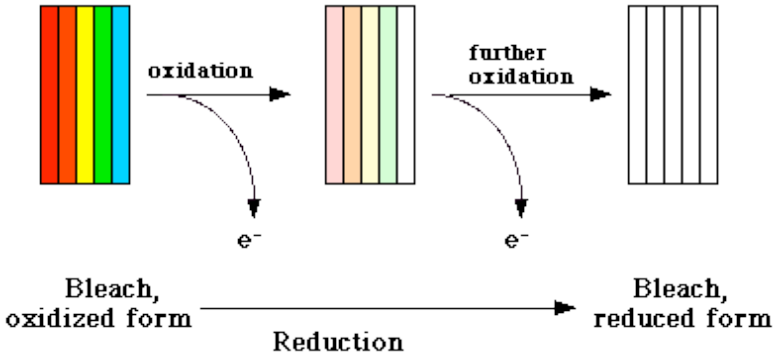
Bleaching Agents

- Bleaching agents are compounds which are used to remove color from substances such as textiles.
- In earlier times textiles were bleached by exposure to the sun and air.

Bleaching Agents

- Today most commercial bleaches are oxidizing agents, such as sodium hypochlorite (NaOCl) or hydrogen peroxide (H_2O_2), which are quite effective in "decolorizing" substances via oxidation. The action of these bleaches can be illustrated in the following simplified way:

Bleaching Agents



Bleaching Agents

- The decolorizing action of bleaches is due in part to their ability to remove these electrons, which are activated by visible light to produce the various colors. The hypochlorite ion (OCl^-), found in many commercial preparations, is reduced to chloride ions and hydroxide ions forming a basic solution as it accepts electrons from the colored material as shown below.
- $OCl^- + 2e^- + HOH \text{ --------> } Cl^- + 2\ OH^-$


STRANGE BREED by Steve Langille
EDWARD, WHY DO YOU ALWAYS HAVE TO BE SO NEGATIVE ?!
+
-
9 VOLTS
Ene
THE NAGGING KEEPS ON GOING AND GOING...